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(54) METHOD OF MANUFACTURING A CONTACT BODY AND A CONTACT BODY MANUFACTURED BY THE METHOD

(71) We, AKTIEBOLAGET CARL MUNTERS, a Swedish Company of Industrivagen 2, 191 47 Sollentuna, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a method of manufacturing a contact body in which layers of asbestos are so arranged that the layers bear against one another at mutually speed positions so as to form a plurality of channels extending from end to end.

The spacing of the layers of the contact body may be effected in any known manner for example alternate layers may be wholly or partially corrugated or formed with longitudinal protruberances which bear against interposed plane layers.

A contact body of the kind defined in the above introduction is known from e.g. the British Patent Specification No. 1,140,042. As is evident from this Patent Specification the body may be built up of alternate plane and corrugated layers of asbestos paper of a commercially available kind. In this connection, there is initially formed a web composed of two layers or strips of asbestos paper of which one is formed with folds or corrugations with the folds running parallel to one another and the other is plane. The two layers are glued together at the fold ridges e.g. with water-glass to form a single-waved structure, from which a contact body blank of desired size is built up for example by coiling the composite web formed into cylindrical shape. The cylindrical shape is especially suited, if the contact body is to be placed into a cylindrical passage e.g. the exhaust gas pipe from an internal combustion motor or be used as rotor in an exchanger apparatus. The body may be manufactured in other ways, e.g. by sawing out sectors or segments to intended, such as cylindrical, form from a block of the layers. The height of the corrugations or folds which determines the spacing between the plane layers is preferably less than 3 mms, e.g. 1.5 mm. The average spacing between the layers must thus be less than 1.5 mm. Once so formed the body is heated to sintering temperature together with one or more substances containing silicon and aluminium.

A contact body of this kind is primarily intended for action on gases at high temperatures or is subjected to large variations in temperature as is the case in heat exchangers for utilizing the heat content of the exhaust gases in gas turbines or when the contact body constitutes a carrier for catalysts.

An object of the invention is to provide a contact body which withstands very high temperatures and which in addition withstands large variations in temperature by having a low heat expansion coefficient.

According to the present invention a method of manufacturing a contact body comprises the steps of, forming layers of asbestos arranged so that the layers bear against one another at mutually spaced positions to provide a plurality of channels in the body extending from end to end, adding to the asbestos fibres, either before or after the forming step, a predetermined quantity of silicon and aluminium, and thereafter heating the body together with the silicon and aluminium to sintering temperature, the addition of the silicon and aluminium being adjusted so that the sintered layers of the product include 45—55% SiO_2, 30—45% Al_2O_3 and 10—20% MgO by weight.

Preferred values for the three components are 47—52% SiO_2, 32—40% Al_2O_3 and 12—18% MgO by weight.

The invention in one preferred form includes a method of manufacturing a contact body comprising the steps of, forming layers of asbestos arranged so that the layers bear

against one another at mutually spaced positions to provide a plurality of channels in the body extending from end to end thereof; immersing the body in a solution containing silicon; treating the body to precipitate SiO_2 thereon; thereafter immersing the body in a solution of aluminium oxide, and then sintering the body; the immersing steps being performed so that the sintered layers of the product include between 45—55% SiO_2, 30—45% Al_2O_3 and 10—20% MgO by weight.

According to another aspect of the invention a contact body comprises layers of asbestos sintered together with a predetermined quantity of silicon and aluminium and arranged so that the layers bear against one another at mutually spaced positions to provide a plurality of channels extending from end to end of the body, the sintered layers including 45—55% SiO_2, 30—45% Al_2O_3 and 10—20% MgO by weight.

By forming a contact body in this way it has a low heat expansion coefficient so that the body neither warps nor is impaired in any other way even if it is subjected to large temperature changes such as from room temperature up to 800°C in a short time.

In one embodiment of the invention the contact body blank built up from asbestos layers initially can be immersed into a water-glass solution having a composition from $Na_2O \cdot 1.6\ SiO_2$ to $Na_2O \cdot 4\ SiO_2$. The solution to be most suitable should have a dry substance content of 20—40%, preferably 25—30%. As an alternative, it may be based on a potassium silicate solution of corresponding composition. After that, the excess water-glass is blown out from the channels of the body and the body then immersed into a liquid having a great affinity to water such as concentrated alcohol solution, whereby the remaining water-glass is transferred into a kind of gel form, the body at the same time obtaining increased strength. The contact body is now immersed into a liquid or a gas is passed through the body in order to precipitate SiO_2 from the water-glass. The liquid may be constituted by an acid, such as hydrochloric acid, nitric acid, sulphuric acid, phosphoric acid, acetic acid, citric acid or oxalic acid or by ammonium salt solution, such as ammonium carbonate, bicarbonate, phosphate, sulphate, chloride or acetate.

As an alternative, a gas such as CO_2 for example, may act as precipitating agent.

After rinsing and drying the contact body blank is subjected to renewed treatment with the two components as above, until the asbestos layers have received a predetermined quantity of SiO_2, which calculated on the quantity of asbestos fibres must be 100—130%.

Subsequently, the contact body is immersed into a colloidal solution of aluminium oxide for supplying a predetermined quantity of Al_2O_3. The concentration and viscosity of the solution must be of an order so that it can penetrate into the pores between the fibrils or filament bundles of the asbestos fibres. Thereupon, the contact body is dried at 90—175°C, and then a renewed immersion into a colloidal solution of Al_2O_3 is effected until the quantity of Al_2O_3 in the body blank amounts to 100—120% of the quantity of asbestos fibres.

The asbestos contains oxides of magnesium and silicon as essential components and in a quantity calculated as percentage which may vary according to the locality of origin. The quantity of each usually is kept within the limits of 37—44% but the asbestos type of particular interest for this application is chrysotile. After the content of MgO for a certain asbestos quality has been determined, the relation between the resident quantity of MgO and SiO_2 contained therein and the externally supplied components SiO_2 and Al_2O_3 by the impregnation steps described above, is adjusted preferably so that MgO is contained as 15%, SiO_2 as 50% and Al_2O_3 as 35%. These values may be varied by a few percent upwards or downwards but must, according to the invention, be kept within the limits stated above. However it is suitable to keep the quantity of SiO_2 within 47—52% and that of Al_2O_3 within 32—40%.

The contact body then is sintered at a temperature within the range of 1000—1250°C to obtain a coherent body of the sintered layers which practically is unaffected by very large and sudden changes in temperature. It also has a high capacity of withstanding chemicals of different kinds.

Small quantities of additives can be used to render the sintering process easier. These agents e.g. Zn or Li, can be added in connection with the precipitation of the SiO_2.

In another embodiment of the invention, the Si-Al-components are mixed with the bulk of asbestos fibres from which the sheets or layers are produced. As examples of such additives in solution or suspension are:

a)	Kaolin	150—250% of the asbestos quantity
b)	$SiO_2+Al_2O_3$	80—120 and 70—130% respectively
c)	$SiO_2+AlO(OH)$	80—120 and 80—150% respectively
d)	$SiO_2+Al(OH)_3$	80—120 and 100—200% respectively
e)	Al_2O_3+pyrophyllite	30—50 and 100—170% respectively

The quantity of the added substance or substances is adjusted so that the proportions between the three main components becomes that stated above.

In the manufacture of asbestos paper normally a small quantity of organic binding agents is added the purpose of which is to increase the mechanical strength of the finished paper. In practice, one adds for this purpose organic substances in amount up to 15 per cent by weight. In this embodiment the produced asbestos paper will contain so much externally added components that the paper could not be handled during those treatments, e.g. corrugation of the layers, which are required for building up a blank of the contact body. Therefore to reduce the proportion of additives, calculated on the weight of the finished absbestos paper, preferably substantially more organic substances than normal are added at the beginning in the form of fibres and binding agents to the asbestos fibre bulk. This addition which may amount to 50% or more of the weight of the paper, is burnt off during the sintering step and therefore is only used during the shaping proper of the body of layers since paper with this greater proportion of organic material is more easily shaped.

The asbestos paper manufactured in this manner, and which may have a thickness of 0.1—0.5 mm is folded or formed with protuberances in a wetted state. The wetting may be effected by addition of a solution of Na- or Ka-water-glass. This makes sure that the folded structure obtains a rigidity which additionally facilitates the building up of the contact body blank. After the blank has been formed there follows the heat treatment at 1000—1250°C and the final product then obtains the same composition as stated above.

Minor additions for improving the sintering properties may be made in the form of, for example, ZnO, Zn silicate, Li silicate Cr_2O_3, CaO or Ca silicate. These additives must constitute only a few per cent of the weight of the final product.

Due to their hardness and the capacity of retaining their shape contact bodies manufactured according to the invention may also find application in e.g. heat and/or moisture exchangers e.g. between two air streams where the temperature is more moderate. In a moisture exchanger or drier the exchanger body serves as a carrier for a hydroscopic substance, such as LiCl. The invention can also be used as packing in cooling towers or moisteners, in which water and air are brought to contact with one another. Examples of such exchangers can be found in the British Patent Specification Nos. 1,073,315, 1,055,796 and 1,232,432.

Although the invention has been particularly described with reference to the specific embodiments described above variations of the disclosed methods may be made. For example one of the components e.g. the Al-compound, may be fed into the fibre bulk, of which the paper layers are manufactured while the second component, such as the silicon compound, may be supplied after the contact body has been formed. Alternatively, a portion of at least one component can be added to the fibre bulk, whereas the remainder of that component is supplied to the shaped body.

It may be mentioned that in our prior British Patent No. 1,140,042 there is described and claimed a method for the manufacture of an exchanger packing intended for the exchange of heat and/or moisture between two fluids at least one of which is a gas, wherein the packing comprises asbestos fibre layers which bear against one another at mutually spaced places and therebetween form passageways open from end to end and extending through the packing and the strength of which layers is increased by means of one or more inorganic substances, characterized in that the substance or substances is/are heated to a temperature which is higher than the critical temperature of the asbestos, so that the substance or substances forms or form a skeleton considerably improving the strength of the layers after cooling.

Also in our prior British Patent No. 1,343,149 there is described and claimed a method of treating an exchanger packing useful for heat or moisture exchange in an air conditioning system, said packing comprising fibrous sheets having corrugations extending from end to end for passage of gases through the packing, comprising wetting the packing body with an aqueous solution of an inorganic salt and then exposing the packing, wet with the solution, to a gas reactive with said inorganic salt to precipitate an insoluble substance, the insoluble substance providing improved wet strength of the sheets.

WHAT WE CLAIM IS:—

1. A method of manufacturing a contact body comprising the steps of, forming layers of asbestos arranged so that the layers bear against one another at mutually spaced positions to provide a plurality of channels in the body extending from end to end, adding to the asbestos fibres, either before or after the forming step, a predetermined quantity of silicon and aluminium, and thereafter heating the body together with the silicon and aluminium to sintering temperature, the addition of the silicon and aluminium being adjusted so that the sintered layers of the product include 45—55% SiO_2, 30—45% Al_2O_3 and 10—20% MgO by weight.

2. A method according to Claim 1 wherein the sintered layers of the product include 47—52% SiO_2, 32—40% Al_2O_3 and 12—18% MgO by weight.

3. A method according to Claim 1 or 2 wherein the adding step is performed before the forming step and comprises adding two separate substances to the asbestos containing

respectively silicon and aluminium, the substances being mixed to the fibre bulk of which the asbestos layers are formed.

4. A method of manufacturing a contact body comprising the steps of, forming layers of asbestos arranged so that the layers bear against one another at mutually spaced positions to provide a plurality of channels in the body extending from end to end thereof; immersing the body in a solution containing silicon; treating the body to precipitate SiO_2 thereon; thereafter immersing the body in a solution of aluminium oxide, and then sintering the body; the immersing steps being performed so that the sintered layers of the product include between 45—55% SiO_2, 30—45% Al_2O_3 and 10—20% MgO by weight.

5. A method according to Claim 4 wherein the step of immersing the body in a solution containing silicon comprises the step of immersing the body in a solution having a composition of from $Na_2O.1.6\ SiO_2$ to $Na_2O.4\ SiO_2$ having a dry substance content of between 20% and 40%, or a potassium silicate solution of corresponding composition.

6. A method according to Claim 5 including the step of immersing the body, after immersion in the solution containing silicon, in a liquid having an affinity for water.

7. A method according to Claim 5 wherein the step of treating the body to precipitate SiO_2 comprises the step of immersing the body in an acid or ammonium salt solution wherein the acid is hydrochloric acid, nitric acid, sulphuric acid, phosphoric acid, acetic acid, citric acid or oxalic acid.

8. A method according to Claim 5 wherein the step of treating the body to precipitate SiO_2 comprises the step of passing CO_2 gas through the body.

9. A method according to Claim 5 wherein the sintering step comprises the step of sintering the body at a temperature range of 1000° to 1250°C.

10. A contact body comprising layers of asbestos sintered together with a predetermined quantity of silicon and aluminium and arranged so that the layers bear against one another at mutually spaced positions to provide a plurality of channels extending from end to end of the body, the sintered layers including 45—55% SiO_2, 30—45% Al_2O_3 and 10—20% MgO by weight.

11. A method of manufacturing a contact body according to any of Claims 1 to 9 substantially as hereinbefore described.

12. A contact body according to Claim 10 substantially as hereinbefore described.

WITHERS & ROGERS,
Chartered Patent Agents,
4 Dyers Buildings,
Holborn,
London, EC1N 2JT.
Agents for the Applicants.

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